Educational Series & Academy

MULTI-SCALE, MULTI-PHYSICS, AND MULTI-TECHNIQUE COMPUTATIONAL TOOLS FOR MATERIALS COMPUTATIONAL MODELLING

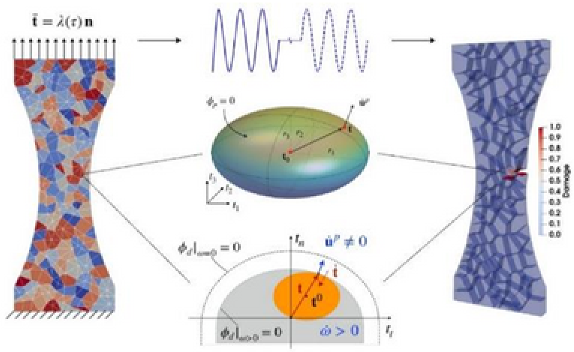
The short course will describe the main aspects of recently developed two- and three-dimensional computational frameworks for multi-scale and multi-physics analysis of polycrystalline and composite materials, including the representation of degradation and failure, based on the employment of techniques different from standard FEM.
The described models are based on the explicit representation of the considered materials mechanics at the meso-scale, including the initiation, evolution and coalescence of micro-damage and cracking. The strategies to capture the exchange of information between different scales, namely the component level (macroscale) and the material level (mesoscale), will be described, as well as the techniques to include multi-physics representations (e.g. piezoelectric, thermoelastic, chemical diffusion).
The potential benefits of employing different techniques for different material phases will be discussed and an example about the coupling of the recent developed Virtual Element Method and the Boundary Element Method will be presented.
The course will describe the main features of the proposed frameworks, their main advantages, current issues, and direction of potential further development. Several applications to the computational analysis of damage initiation and micro-cracking of common and piezoelectric polycrystalline aggregates under different loading conditions will be discussed. Examples about modelling damage initiation and evolution in composite unit cells will be presented.

Syllabus

-A boundary element computational framework for micromechanics (2 hours)
-The boundary element method: integral equations and their numerical treatment (4 hours)
-Introduction to the Virtual Elements Method (2 hours)
-Construction of a boundary elements multiscale formulation including damage and failure (2 hours)
-Multi-scale, multi-physics and multi-technique formulations for materials modelling (2 hours)

LEARNING OBJECTIVES

At the end of the class the attendees will have learned how to use integral equations to model solids mechanics problems, will have a clear understanding of strengths and weaknesses of the Boundary Element Method, and will know how to use it in combination with other techniques, such as FEM, VEM, Cohesive Zone Modelling, Continuum Damage Mechanics to address a wide range of materials mechanics problems.



Target audience: The class is addressed to PhD students or researchers with no previous exposure to the Boundary Element Method or the Virtual Element Method, who are working on or are interested in solids mechanics, damage and failure modelling, micro-mechanics, and multi-scale materials analysis.

DATES AND TIME: 8-9 MAY 2023, 9.00-12.00 & 10-12 MAY 10.00-12.00

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REGISTRATION AND CONTACTS

Course Code: 20230508

This course is part of the 2023 institutional activity for AIDAA members. The registration requires the purchase of one of the packages described here https://www.aidaa.it/package-list/, and the completion of the online form available on AIDAA webpage.

Course platform: Webex, a link will be sent via email as the registration is complete.
At the end of each course, **attendance certificates** will be sent to participants via email.

For further info, please, contact **academy@aidaa.it**

SPEAKER

Ivano Benedetti is an Associate Professor (with the Italian scientific qualification for the role of Full Professor) of Aerospace Structures in the Department Engineering of the University of Palermo (UniPa, Italy).
In the same Department he currently serves as Head of the Master's Degree of Aerospace Engineering.
His research focuses on analytical, numerical, and computational modeling of materials & structures. Has published several research articles on subjects related to: Multiscale materials modelling; Micro and nano-mechanical modelling of engineering materials; Finite, Virtual and Boundary Element Methods (FEM, BEM, VEM) for damage & fracture mechanics; Fast BEM solvers based on the use of Hierarchical Matrices; Modelling of composite, polycrystalline, lattice and piezoelectric materials. Currently his research is focusing on Multiscale modelling of damage and failure mechanisms in engineering materials including composite, polycrystalline and lattice materials.
Overall, he is author of more than 125 publications in peer reviewed International Journals, book chapters and proceedings of international and national conferences.